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# PHARMACOSOMES: A POTENTIAL LIPID BASED CARRIER FOR DRUG DELIVERY

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**ABSTRACT**

Target-specific drug-delivery systems for the administration of pharmaceutical compounds enable the localization of drugs to diseased sites. Various lipid based vesicular systems have been developed as controlled and targeted drug delivery systems. Pharmacosomes are colloidal, nanometric size micelles, vesicles or may be in the form of hexagonal assembly of colloidal drug dispersions attached covalently to the phospholipid. Pharmacosomes are novel and potential alternative to conventional vesicles. Pharmacosomes enable to enhance solubility and bioavailability of the encapsulated drug. This drug delivery system is a reliable, safe and stable.Pharmacosomes are compared with other vesicular drug carriers like Niosomes, Liposomes, Ethosomes and transferosomes. They are mainly prepared by using various techniques like hand-shaking, ether injection method, solvent evaporation method etc. These prepared pharmacosomes have been characterized for different parameters such as size, surface morphology and in vitro release rate etc. These pharmacosomes have been developed using number of drugs which are used for inflammation, heart diseases, cancer, and protein delivery. This narrative review describes the fundamental aspects of pharmacosomes including structure, components, and methods of preparation, advantages, and applications.

## INTRODUCTION

Many researchers and scientists have been working on novel drug delivery system from past few decades, with an aim to develop the system. The main purpose for developing this system is to explain the basis of clinical use of these systems, and their economic aspects [1]. An ideal novel drug delivery system should fulfill two factors:

- It should deliver the drug by depending on the body requirements,
- It should deliver the active entity to the target site of action [2].

The use of this system is to modify the original bio distribution of drugs and to entrap them in submicroscopic drug carriers such as transferosomes, niosomes, ethosomes, liposomes, Serum proteins, erythrocytes, reverse micelles, monoclonal antibodies, and pharmacosomes [3]. In the recent years, these lipid vesicles were found to have more importance in the field of immunological studies, membrane biology, diagnostic purpose and its techniques and mostly in genetic engineering [4]. Vesicular structures are the systems that prolong the duration of action of the drug in systemic circulation, and reduce toxicity by selective uptake [5]. These vesicles which are developed were first reported in 1965 by Bingham, and these vesicles are named as “Bingham bodies” which play an important role in modeling biological membranes, and in transporting of drug and targeting of drug at site of action [2].

**1.1. Pharmacosomes:** Pharmacosomes belong to the part of novel drug delivery system. They were first introduced by vaizoglu and Speriser in 1968 [2]. These bear unique advantages over liposome and niosome vesicles and serve as an alternative to conventional vesicles. These are the colloidal dispersions of drugs that covalently bounded to lipids which form complexes. Depending upon the structure and chemical features of the drug-lipid complex they may exist as ultra-fine, micelle, or hexagonal aggregates. These are formed by linking a drug (pharmakon) to a carrier (soma), so this system is termed as "pharmacosomes". This system serves as a major tool to achieve desire therapeutic goals in terms of drug targeting and controlled release of drug. The importance of developing these vesicular pharmacosomes is dependent on surface and bulk interactions of lipids [6]. The schematic diagram of pharmacosome shown in the Figure.1[44].

**1.2. Mechanism of drug entrapment in the pharmacosomes:**

Any drug possessing an active hydrogen atom can be esterified into the lipid, having spacer chain or no spacer chain that strongly result in the formation of an amphiphilic compound, which helps in better drug penetration in to the target site. The prodrug which contains the both hydrophilic and lipophilic properties, thus impart amphiphilic characters. This amphiphilic nature helps pharmacosomes to decrease the interfacial property and at increased contraction produce mesomorphic behavior. This decrease in the interfacial tension leads to an increase in the contact area, thereby increasing the bioavailability of drug [7].The phospholipids, when placed in water form micelles or are organized as lipid bilayers with the hydrophobic tails lined up against one another and the hydrophilic headgroup facing the water on both sides. These unique features make phospholipids suitable to be used as excipients for poorly water soluble drugs [8]. The information regarding drug entrapment and structural features of various vesicular systems given in table 5.

**1.3. HowPharmacosomes differ from other vesicular systems**

Development of pharmacosomes have been introduced to overcome the problems associated with other vesicular systems and to incorporate poorly water soluble and other drugs. Pharmacosomes bearing unique advantages over liposome and niosome vesicles, have come up as potential alternative to conventional vesicles. The information regarding the structure, applications of other vesicular systems and over that advantages of pharmacosomes given in the Table.1 [45] and Figure.2 shows the structural differences among other vesicles[46].

**1.4. Advantages of Pharmacosomes [7]:**

1. Membrane fluidity has no effect on release rate due to covalent linkage.
2. Leaching of drug does not takes place.
3. Drugs can be delivered directly at the targeted site.
4. Drug releases by hydrolysis.
5. Stable and efficiency due to covalent linkage.
6. Low cost of therapy
7. Hydrophilic and lipophilic drugs are suitable.
8. High and predetermined drug loading.
9. High entrapment efficiency.
10. No need of removing the free un-entrapped drug.
11. Improves bioavailability.
12. Reduction in adverse effect and toxicity.

**1.5. Salient features of Pharmacosomes [9]:**

1. Biocompatible and biodegradable
2. Nontoxic, non-immunogenic and non-carcinogenic
3. High and predetermined entrapment efficiency.
4. No need to follow any difficult and time taking steps to remove the un-entrapped drug.
5. Leakage of drug does not take place but loss may occur by hydrolysis.
6. Easy to incorporate the drug into the lipids.
7. Uncaptured volume and drug-bilayer interactions do not influence the entrapment efficiency.

8. Lipids transfer and HDL solubility is low.
9. These can be varied relatively precisely for optimized in vivo pharmacokinetics.
10. Given in different routes like oral, topical, extra or intra vascularly.

**1.6. Limitations [8]:**

1. Compound synthesis depends upon its amphiphilic nature.
2. Requires both surface and bulk interaction.
3. Covalent bonding is required to protect the leakage of drugs.
4. On storage these undergo fusion, aggregation and chemical hydrolysis.

**2. Components of Pharmacosomes:** For this delivery system the three components are drugs, solvent and carriers (lipid).

**2.1. Drugs:** Any drug possessing an active hydrogen atom from amino, carboxyl or Hydroxyl group which can be esterified into the lipid, having spacer chain or no spacer chain that strongly result in the formation of an amphiphilic complexes. These amphiphilic complexes (pharmacosomes) which are formed or prepared, facilitates membrane, tissue, or cell wall transfer, in the organism[10].Various drugs like non-steroidal anti-inflammatory drugs (NSAIDs), cardiovascular drugs, antineoplastic drugs and proteins, anti-fungal drugs are used in the preparation of pharmacosomes.

**Drug characteristics**

- Both hydrophilic and lipophilic drugs are suitable
- Should have active Hydrogen atom from functional groups like amino,carboxyl and hydroxyl
- Drug should be covalently bound with lipids
- Poorly soluble drugs

**2.2. Lipids:**

Phospholipids are the major structure component of biological membranes, where two types of phospholipids such as phosphoglycerides and sphingolipids are generally used [11]. The most common phospholipid used is phosphotidylcholine. Phosphotidyl choline is an amphiphilic molecule having a pair of hydrophobic acyl hydrocarbon chains which are linked by glycerol bridges, with a hydrophilic polar head group phosphocholine. Most commercial lecithin products contain 20% phosphatidylcholine. Lecithin's containing phosphatidylcholine can be obtained from vegetables (mainly), animals and microbial sources. This phosphotidyl choline is also available as a dietary supplement in two forms: as granular lecithin; and as capsules containing a dispersion in oil.

**Quantity and quality of phospholipids on the pharmacosomes:** In the preparation of pharmacosomes, phospholipid plays important role .By increasing the lipid concentration vesicle size will be increased due to this drug loading will be more and the drug release will also be more. The nature of pharmacosomes are greasy if they prepared by the help of lipids that show low purity grades and resulting in formation of massive aggregates and those fabricated by using high grade purity lipids i.e. over 90% purity grade show status to degradation because of oxidation, that complicated stability[1][4]. Therefore, 80% purity grade is that the usually used phospholipid grade and resultant pharmacosomes showed rough, non-sticky and free flowing nature. Vesicle size, drug content, drug release and surface morphology of the pharmacosomes depends on the quantity and quality of lipids used.

Phosphotidylcholine place a vital role in supporting vesicle membrane integrity and basic structure.

**2.3. Solvent:** Organic solvent of analytical grade and intermediate polarity is used for development of pharmacosomes. It must be of high purity and volatile in nature. The phospholipids and the drug must be dissolved in the selected solvent. The selection of solvent depends on polarity of the drug and the lipid [12]. Examples of various solvents used in the preparation of pharmacosomes: Dichloromethane, methanol, chloroform, ethanol etc. The information about the polarity of solvents used in pharmacosomes preparation are given in Table.2.

**3. Preparation methods of Pharmacosomes:**

There are various methods which have been employed to prepare vesicles:

**3.1. Solvent evaporation method [13]:**

In the solvent evaporation method, the drug is first acidified using 0.1N HCl so that the active hydrogen might be available for complexation. The drug acid is then extracted into chloroform and it is subsequently recrystallized. The drug lipid complex is prepared by associating drug

acid with lipid in various molar ratios. The accurately weighed lipid and drug acid taken in a 100 ml round bottom flask and it is dissolved in sufficient amount of solvents like dichloromethane or methanol. Then this mixture is refluxed for one hour. The solvent which is present is evaporated off under vacuum at 40 ° C in a rotary vacuum evaporator. The dried residues are then collected and placed in vacuum desiccator for complete drying.The schematic representation of solvent evaporation methods is shown in Figure.3[47]:

**3.2. Hand –shaking method [14]:**

In hand shaking method, weigh accurately drug and lipid and dissolve them in volatile organic solvent such as dichloromethane in a round bottom flask. The organic solvent which is present in the flask removed at room temperature using a rotary vacuum evaporator, which leaves a thin film of solid mixture deposited on walls of flask. The dried film can then be hydrated with aqueous media at 50 - 60°C and gives a vesicular suspension.The schematic representation of Hand shaking method is shown in Figure.4. [48].

**3.3. Ether injection method:**

In this method solution containing drug-lipid complex is mixed properly using di ethyl ether as organic solvent and is slowly injected into a hot aqueous medium through gauze needle at 55-65°C and reduced pressure. Vaporization of ether leads to formation ofvesicles [9].The schematic representation of Ether injection method is shown in Figure.5. [48].

**3.4. Anhydrous co-solvent lyophilization method:**

First of all drug and phospholipids are dissolved in solution of dimethyl sulfoxide containing glacial acetic acid. Then mixture is agitated to get clear liquid and then freeze-dried overnight at condenser temperature. The resultant complex is flushed with nitrogen and stored at 4° C [15].

**3.5. Supercritical fluid process:**

This method is known as solution enhanced dispersion by complex supercritical fluid. Drug and lipid complex are premixed in a supercritical fluid of carbon dioxide, then high super saturation is obtained by passing through the nozzle mixture chamber. Theturbulent flow of solvent and carbon dioxide results in fast mixing of dispersion leading tothe formation of pharmacosomes.

The schematic representation ofSupercritical fluid process is shown in Figure.6. [11].

**3.6. Recent approaches:**

- A biodegradable micelle forming drug conjugate was synthesized from the polymer consisting of polyxyethylene glycol and polyaspartic acid with an Adriamycin which is hydrophobic in nature. Diluting the micelle without the active constituent getting precipitated in the monomeric drug conjugate [16].
- Diluting lyotropic liquid crystals of amphiphilic drug [17].

**4. Characterization of Pharmacosomes:**

**4.1. Complex Determination:**

The formation of complex and conjugate can be determined by the correlation spectrum observed in complex sample with that of discrete constituents and also with their mixture with the help of FTIR spectrum[7].

**4.2. Surface Morphology:**

The surface morphology can be predicted using Scanning Electron Microscopy (SEM) or Transmission Electron Microscopy (TEM). The shape and size of pharmacosomes are prone to variations by some variables such as rotation speed, vacuum applied, and Purity grade of phospholipids or the method used.

**4.3. Solubility studies:** Solubility is determined by placing the known amount of phospholipid complex in a screw caped penicillin bottle containing aqueous phase buffer solution of varying pH (2-7.4) and organic phase like 1-Octonol with continuous shaking at a temperature of 37°C for 24hrs. Then both the layers will be separated and samples were analyzed using HPLC or UV spectrophotometer [18].

**4.4. X-ray power diffraction (XRPD):** XRPD is used to determine the degree of crystallinity by using the relative integrated intensity of reflection peaks. The integrated intensity is given by the area under curves of the XRPD patterns and it represents the specimen characteristics[19].

**4.5. Drug content:** To determine the drug content in drug – lipid complex, complex equivalent to drug weighed and added into volumetric flask with suitable solvent. The solution is then mixed by use of magnetic stirrer. After 24 hrs suitable dilution drug content is determined using UV spectrophotometry [18].

**Table.1. Table.1.The structure, applications of other vesicular systems and over that advantages of pharmacosomes**

| Vesicular system | Structure | Problem associated | Applications | Advantages of pharmacosomes over other vesicular systems |
|---|---|---|---|---|
| **Liposomes** | Microscopic vesicle (25nm to 100μm) of one or more lipid bilayers, separated by water or aqueous buffer compartment | Expensive to prepare, degradation by oxidation, sedimentation, leaching of drug, lack of purity of natural phospholipids | Used in ergosterol membrane, protein synthesis inhibitor, decrease Intra-ocular pressure, inhibition of Prostaglandin, phosphor diesterase, cyclo-oxygenase enzyme inhibitor. | Cheaper to prepare, entrapment efficiency is independent of inclusion volume and drugbilayer interactions ,covalent linkage prevent drug leakage, oxidation resistant and pure &natural phospholipids not needed. |
| **Niosomes** | Microscopic lamellar structures of size range between 10 to 1000 nm and mainly composed of biodegradable, and biocompatible surfactants. | Leaching of drug, Timeconsuming , insufficient stability | Used as anti-cancer, anti-infective agent, anti-inflammatory agent and used in ophthalmic drug delivery, oral drug delivery, transdermal drug delivery, brain targeted delivery system for the vasoactive peptide. | More stable, more efficient |
| **Transferosomes** | Ultradeformable vesicles consisting of a lipid bilayer with phospholipids and an edge activator and an ethanol/aqueous core and their size is 300nm | Expensive, Oxidativedegradation, lack ofpurity of natural Phospholipids. | Have the potential for providing controlled release of the administered drug and increasing the stability of labile drugs. | Cheaper ,oxidation resistant , pure &natural phospholipids not needed |
| **Ethosomes** | Soft, malleable vesicles composed mainly of Phospholipids, ethanoland water having a size range from tens of nanometers to microns. | Poor yield, Loss of product during transfer form organic to water media. | Vesicles of choice for transdermal drug delivery of hydrophilic and impermeable drugs. Used in treatment of AIDS, Diabetes. Parkinson Syndrome. | High yield will be there and loss of drug is not seen. |

**Table.2.Polarity of solvents**

| Solvents | Relative Polarity |
|---|---|
| Dichloromethane | 0.327 |
| Methanol | 0.762 |
| Chloroform | 0.259 |
| Ethanol | 0.654 |

**Table.3. Research work done on Pharmacosomes: [22-43]**

| S.No | Drug | Solvent | Technique | Result |
|---|---|---|---|---|
| 1 | Aceclofenac | Dichloromethane | Solvent evaporation | Improved solubility & dissolution profile |
| 2 | Naproxen | Diethyl ether, ethanol, acetone | Ether injection method | Enhancement of solubility and controlled drug release |
| 3 | Ketoprofen | Dichloromethane | Conventional solvent evaporation method | Improved solubility and bioavailability |
| 4 | Diclofenac | Dichloromethane | Solvent evaporation | Improved solubility and dissolution profile |
| 5 | Rosuvastatin | Chloroform, dichloromethane | Solvent evaporation | Sustained drug release and improved bioavailability |
| 6 | Etodolac | Acetone, dichloromethane, methanol | Thin film hydration | Increased solubility, entrapment efficiency and sustained drug release |
| 7 | Furosemide | Methyl alcohol | Vacuum evaporation | Improved solubility and bioavailability |
| 8 | Ornidazole | Dichloromethane, di ethyl ether | Solvent evaporation method, ether injection method | Sustained drug release and improved bioavailability |
| 9 | Nimesulide | Dichloromethane | Solvent evaporation method | Improved solubility and dissolution profile |
| 10 | Geniposide | Tetrahydrofuran | Vacuum evaporation method | Increase in absorption and permeability |
| 11 | Aspirin | Dichloromethane | Solvent evaporation method | Improved solubility and bioavailability |

| | | | | |
|---|---|---|---|---|
| 12. | Capsaicin | Ethanol | solvent evaporation technique | Showed greater cytotoxicity and potential barrier for cancer therapy |
| 13. | Amlodipine | Dichloromethane | Solvent evaporation technique | Sustained drug release |
| 14. | Pindololdiglyceride | Acetone, dichloromethane | Thin film hydration method | Three to five times increase in plasma concentration and lower renal clearance |
| 15. | Naringenin | Dichloromethane | Solvent evaporation technique | Improved bioavailability |
| 16. | Piroxicam | Chloroform | Solvent evaporation technique | Improved bioavailability |
| 17. | *Kaempferia galangal* rhizome extract | Ethanol | Conventional solvent evaporation method | Improved bioavailability and analgesic activity |
| 18. | Quercetin | Dichloromethane | Solvent evaporation technique | Improved solubility by 12 folds |
| 19. | Baicalein | tetrahydrofuran | discontinuous solvent evaporation method | Improved bioavailability |
| 20. | Ibuprofen | Ethanol | Solvent evaporation method | Improved solubility and dissolution profile |
| 21. | Acyclovir | water | tetrahydrofuran injection | Stability from heat,absorbed by plasma protein in blood and reduced hemolytic reaction |
| 22. | cholesterly–adipoyldidanosine (CAD) | water | tetrahydrofuran injection method | Improved stability |
| 23. | Didanosine | water | tetrahydrofuran injection method | liver targeting and sustained-release effect in the target tissues |
| 24. | Bupranolol hydrochloride | Water | covalently linked to 1, 3-dipalmioyl-2-succinyl-glycerol | Enhanced effect on intra ocular pressure in rabbit |

| | | | | |
|---|---|---|---|---|
| 25. | 20(S)-Protopanaxadiol | - | Thin film dispersion method | Showed bioavailability |
| 26. | 3',5'-Dioctanoyl-5-fluoro-2'-deoxyuridine | - | Thin layer ultra-sonication technique | Improved drug targeting to brain |

**Table: 4 – Mechanism of drug entrapment and structural features of various vesicular systems**

| Sl.no | Vesicular system | Structural features | Mechanism of drug entrapment |
|---|---|---|---|
| 1. | Liposomes | Concentric bilayered vesicle in which an aqueous volume is entirely enclosed by a membranous lipid bilayer mainly composed of synthetic phospholipidswhich are molecules that have a hydrophilic head and a hydrophobic tail group. | Liposomal systems entrap both lipophilic and hydrophilic compounds and enables a diverse range of drugs to be encapsulated by these vesicles. Hydrophobic molecules are inserted into the bilayer membrane, and hydrophilic molecules can be entrapped in the aqueous center. |
| 2. | Niosomes | Microscopic lamellar structures of size range between 10 to 1000 nm and mainly composed of biodegradable, and biocompatible surfactants. | Niosomes are ampiphillicin nature, which allows entrapment of hydrophilic drug in the core cavity and hydrophobic drugs in the non-polar region. |
| 3. | Transferosomes | Ultradeformable vesicles consisting of a lipid bilayer with phospholipids and an edge activator and an ethanol/aqueous core and their size is below 300nm | Transfersome consists of at least one inner aqueous compartment, which is surrounded by a lipid bilayer with specially tailored properties, and the drug is entrapped in middle of the vesicle due to the incorporation of "edge activators" into the vesicular membrane. Both low and high molecular drugs can be entrapped inside the transferosomes. |
| 4. | Pharmacosomes | Amphiphilic, colloidal dispersions of drugs covalently bound to lipids, and may exists as ultra-fine vesicular, micellar, or hexagonal aggregates, depending on the chemical structure of the drug lipid complex. | The drug binds covalently to a lipid where the resulting compound is the carrier and the active compound at the same time.Pharmacosomes can only encapsulate the water insoluble drugs in relatively small hydrophobic regions within membrane bilayer ratherthan large surface. |
| 5. | Ethosomes | These are soft, malleable vesicles composed mainly of phospholipids, ethanol and water having a size range from tens of nanometres to microns. | In ethosomes the drug is entrapped with ethanolic solution present in the vesicle and permeates deeper into skin. They are used to deliver peptides, proteins |
| 6. | Sphingosomes | Concentric, bilayered vesicle in which an aqueous volume is entirely enclosed by a membranous lipid bilayer composed of natural or synthetic sphingolipid. | The drug is binded in between the bilayered membrane and binds with the lipids present in them. |

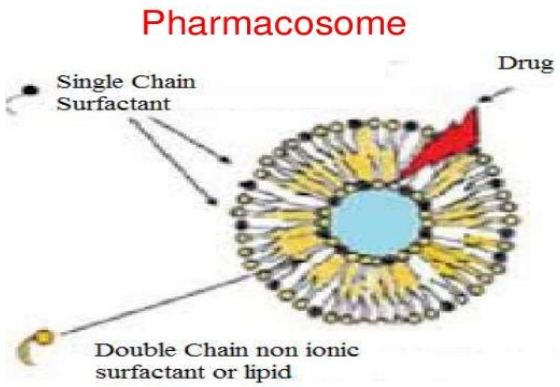


**Figure.1. Structure of Pharmacosome**

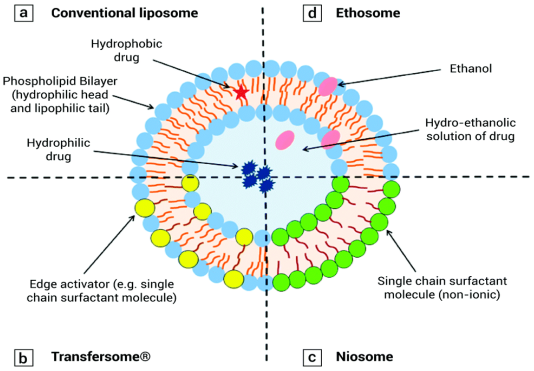


**Figure.2. Schematic diagram of various vesicular systems**

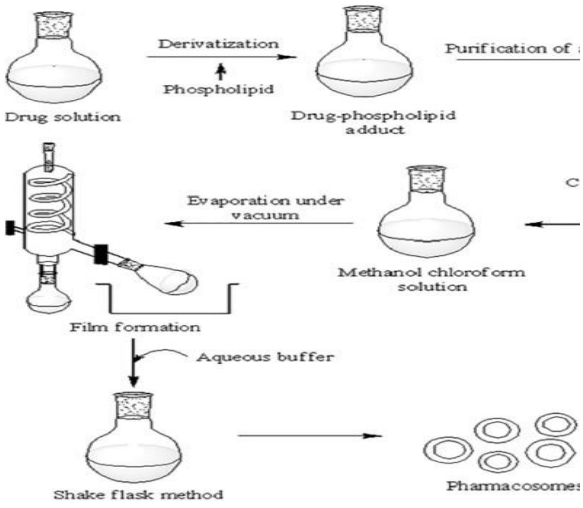


**Figure.3. Solvent Evaporation Method**

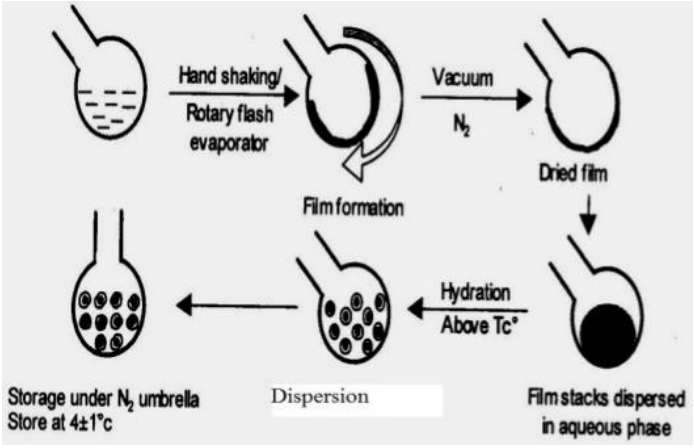


**Figure.4. Hand shaking method**

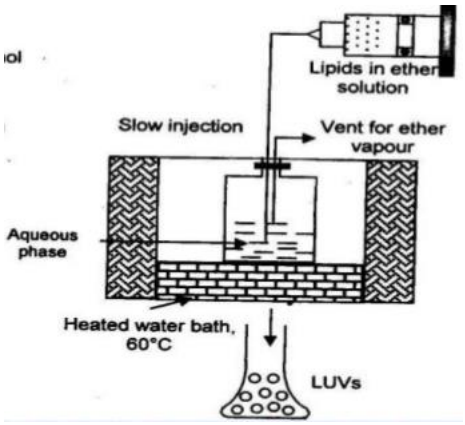


**Figure.5. Ether injection method**

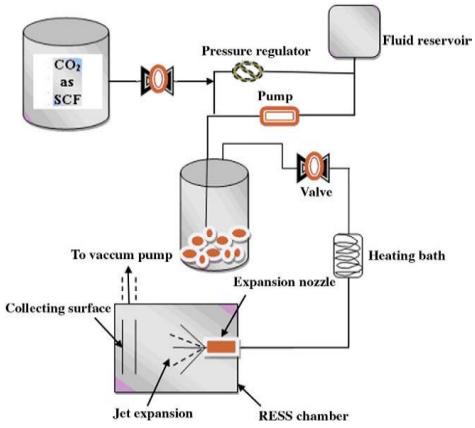


**Figure.6- Super critical Fluid Process**

### 4.6. Differential scanning calorimetry (DSC):

This thermal analytical technique is used to determine the drug-excipients compatibility or interactions. The interaction can be concluded by the elimination endothermic peaks, appearance of peaks and change in peak shape and its onset, peak temperature /melting point and relative peaks area or enthalpy.

**4.7. Fourier transform infrared spectroscopy (FTIR):** FTIR is used to confirm the complex

which formed by comparing the spectrum of complex with the spectrum of individual components and their mechanical mixture. FTIR is an important analytical tool for the evaluation of stability of pharmacosome. Stability can be evaluated by comparing the spectrum of the complex in solid form with the spectrum of its micro dispersion in water after lyophillization at different time intervals [20].

**4.8. *In vitro* drug release studies:** *In vitro* release studies were performed using modified Franz diffusion cell. Pharmacosomal gel of different formulations was placed in the donor compartment and the top of the donor compartment was covered with paraffin film. 200 ml of phosphate buffer pH 7.4 was used as receptor medium to ensure a sink condition. The receptor compartment was maintained at 37°C and stirred by a magnetic bar at 600 rpm. The donor compartment was separated from the receptor compartment by cellulose dialyzing membrane which was soaked in the receptor medium overnight. At predetermined time intervals (15, 30, 45, 60,120,180,240,300,360,420 min.)1 ml aliquots were withdrawn from the sampling port and were replaced with an equal volume of fresh solvent mixture to maintain constant volume. The samples were analyzed spectrophotometrically [29]. *In vitro* drug release rate is also estimated by reverse dialysis bag technique. In this method pharmacosomes are introduced inside the dialysis bag and the receiver phase is placed outside. Dialysis bag containing the continuous phase and they are suspended in a vessel containing the donor phase and stirred at predetermined time intervals, each dialysis bag is removed and the contents are analyzed for drug release. An advantage of this technique is increase in the membrane surface area available for transport from the donor to receptor compartment. Another advantage of this technique is the increased efficiency in terms of staffing as a consequence of reduction in number of steps [22].

**5. Applications of Pharmacosomes[49]:**

- Pharmacosomes possess better stability and shelf life compared to other vesicular drug delivery systems.
- Pharmacosomes used in Targeted drug delivery.
- Delivery of peptide drugs.
- The mechanism of action of drugs and non-bilayer phases can be studied by using pharmacosomes.
- PEGylation and biotinyzation are also used in the production of pharmacosomes.
- Development of novel ophthalmic drug delivery system.
- Ophthalmic drug delivery with a modified corneal drug transport and release by diluting with tears where the drug should be of amphiphilic in nature.
- The mechanism of action of drugs and non-bilayer phases can be studied by using pharmacosomes.
- Phytoconstituents such as flavonoids, glycosides etc., shows both increase in pharmacokinetic and pharmacodynamics actions.
- The ability of transportation of biological components like proteins and amino acids done by using pharmacosomes.
- The approach has successfully improved the therapeutic performance of various drugs i.e. pindolol maleate, bupranolol hydrochloride, taxol, acyclovir etc.
- The phase transition temperature of pharmacosomes in the vesicular and micellar state could have significant influence on their interaction with membranes.
- Pharmacosomes can also prepared by incorporating various drugs related to NSAIDs, Anti-fungal, Anti-hypertensive, Anti-cancer,Anti-viral, Diuretics and nucleic acids etc.

**6. Marketed Preparations:**

- **Human Iron Dextran** is manufactured as low molecular weight Iron Dextran by Pharmacosomes. As the only injectable iron product, **CosmoFer®** offers the flexibility of iron repletion by total dose iron infusion, intravenous and intramuscular iron injection.
- **Veterinary Iron Dextran** is used as iron supplement for prevention of iron deficiency anemia in piglets.**Uniferon®** Iron Dextran drug products are marketed in several countries [50].

**7. CONCLUSION:**

A wide range of drugs can be encapsulated into pharmacosomes. In addition, pharmacosomes possess enhanced

solubility,stability and reduced toxic drug effects, with sustained release of the encapsulated drug. Furthermore,both the lipophilic and hydrophilic drugs can be encapsulated. Drug bonding covalently with the polymer shows increase in entrapment efficiency. Pharmacosomes reduce toxicity and can improve therapeutic performance of drug. A biodegradable micelle forming drug conjugates increasing hydrophilicity of drug, Insummary, Pharmacosomes represent a highly effective tool for drug delivery in the therapeutic regime of numerous diseases and have the potential to provide more efficacious treatment than conventional drug-delivery platforms.

## 8. FUTURE PROSPECTIVE

There are many limitations that are associated with vesicular drug delivery systems, like other vesicular system pharmacosomes plays an important role in the selective targeting, and the controlled delivery of various drugs.Pharmacosomes have immense potential, and advantages over other vesicular systems. The influence of spacer groups and linkages should be observed more rigorously for further improvement in drug fate and biological activity of the drug to achieve the therapeutic goal. The system requires greater efforts towards investigating the non-bilayer phases and exploring the mechanism of action. Pharmacosomes do not have only high entrapment efficiency but delivery can be predetermined, because drug itself in conjugation with lipids forms vesicles. Since pharmacosomes have immense potential, there is need of more work to be done on this system to get more fruitful results.

## 9. Acknowledgement

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